Hindcast & Nowcast of Currents in the Santa Barbara

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Award #:N00014-95-1-0809

LONG-TERM GOALS

To develop a high-resolution, verifiable nowcast and forecast model for the Santa Barbara Channel (SBC) by combining basic understanding of the circulation processes through theory and observations, numerical techniques and data assimilation.

OBJECTIVES

To test the model using inputs from realistic wind and density fields for Dec/97 through May/98, and use the results to study the momentum balance in the channel.

APPROACH

Oey's (1996) nested-grid model for the Southern California Bight (SCB) and SBC (Figure 1) was extended to hindcast and nowcast currents using up-to-date windstresses and CalCofi temperature and salinity (T and S) data during the recent El Nino winter and spring, from Dec/97 through May/98. Windstresses were calculated by combining hourly NDBC wind in the vicinity of the channel with historical, monthly COADS wind over the outer region away from the channel. Historical T and S fields were used to initialize the model, which were then supplemented with a simple data-assimilation scheme that nudged the modeled T/S to CalCofi data of Dec/97 through Apr/98 (Courtesy of Tom Hayward, Scripps Inst. Oceanogr.) The assimilation of CalCofi data introduced waters with temperatures that are approximately 2° warmer than climatology in the Southern California Bight.

WORK COMPLETED

Model code development was completed.

RESULTS

Figure 2 shows examples of surface temperature (left panel) and free-surface elevation (right panel), with surface (left) and 100-m (right) velocity vectors superimposed, for (a) Jan/15, (b) Feb/14, (c) Mar/16 and (d) Apr/15, 1998. Advection of the El Nino warm water by strong poleward coastal current can be seen in January. A momentum balance analysis (Oey et al.,1998) shows that at this time, poleward pressure gradient caused by sea-level tilt is balanced primarily by the tendency term $\partial v/\partial t + \partial v^2/\partial y$. From February through May, the equatorward windstress intensified, and one begins to see the onset of equatorward coastal currents in Figure 2b. The near-shore waters also became cooler

1. REPORT DATE **1998**	2. REPORT TYPE	3. DATES COVERED **00-00-1998 to 00-00-1998**
4. TITLE AND SUBTITLE **Hindcast & Nowcast of Currents in the Santa Barbara**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Princeton University,Program in Atmospheric & Oceanic Sciences,Princeton,NJ,08544**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES **See also ADM002252.**		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **Same as Report (SAR)**	18. NUMBER OF PAGES **5**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

brought about by equatorward advection and upwelling. The upwelling process can be seen clearly in March (Figure 2c), where cool waters are found off the central California coast, and warmer waters are 'pushed back' in the SCB. At this time, a cyclone also begins to form in the western part of the channel, with waters cooler than 11.5^o and sea-level of about –4cm at its center. By April, a significant reversal of the nearshore currents, from being equatorward to poleward, can be seen to originate in the SCB (Figure 2d). Warm waters, and together with it higher sea-level also, begin to propagate poleward along the coast. This phenomenon can be attributed to forcing by the equatorward weakening of the windstress curl that occurs south of Pt.Conception in the SCB (Oey,1996,'98).

IMPACT/APPLICATIONS

Sensitivity experiments were also conducted (details in Oey et al., 1998). Of these, the most important finding is that the SBC circulation depends on the relative intensity of windstresses west and east of the channel. This is because the poleward pressure gradient in the channel tends to be balanced by equatorward windstress. Since friction is small, any imbalance is taken up by the Coriolis acceleration of the cross-channel flow. The acceleration is equatorward if the wind is uniformly intense west and east, and poleward if the wind is much weaker in the east. The former condition induces southward cross-channel flow and corresponds to the observed 'Flood East' or 'Upwelling' scenario as defined by Harms and Winant (1998), while the latter northward cross-channel flow and to the 'Cyclonic' or 'Relaxation' scenario. These results are of practical value as they identify key forcing parameters that will guide in further refinements of the model's skill in the channel.

TRANSITIONS

Results in the form of IEEE binary files have been submitted to the Navy (contact: SAIC) for analysis in conjunction with Apr/May 1998 field experiments in the channel.
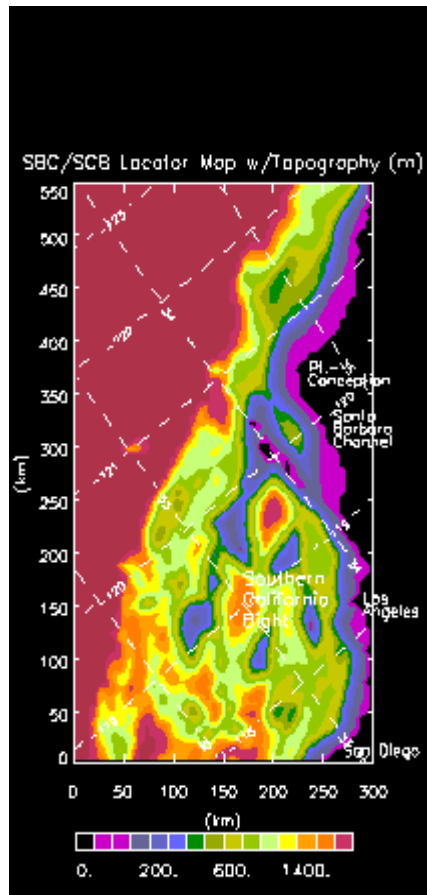
***Figure 1 Santa Barbara Channel and Southern California Bight locator map and model domain
with topography in meters. For computational efficiency, maximum model depth is set to 2000 m.
Dashed rectangle area is the sub-region shown in Figure 2.***

RELATED PROJECTS

The research is in part supported by a grant from The Mineral Management Service (Contract # DOI-10094286; Program Manager: David Brown) via Scripps Institute of Oceanography, so that I work closely with Clinton Winant (SIO) on observational data aspect, and also with Dong-Ping Wang (SUNY), on modeling and data-assimilation aspects.

REFRENCES & PUBLICATIONS

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Figure 2 The one-day averaged surface temperature (left panel) and free-surface elevation contours (right panel), with surface (left) and 100-m (right) velocity vectors superimposed, for (a) Jan/15, (b) Feb/14, (c) Mar/16 and (d) Apr/15, 1998. Five-day averaged wind stresses are also plotted as vectors with thick arrows at four locations. For clarity, only a portion of the model domain (enclosed in dashed rectangle in Figure 1) focusing on the Santa Barbara Channel and vicinity is shown.
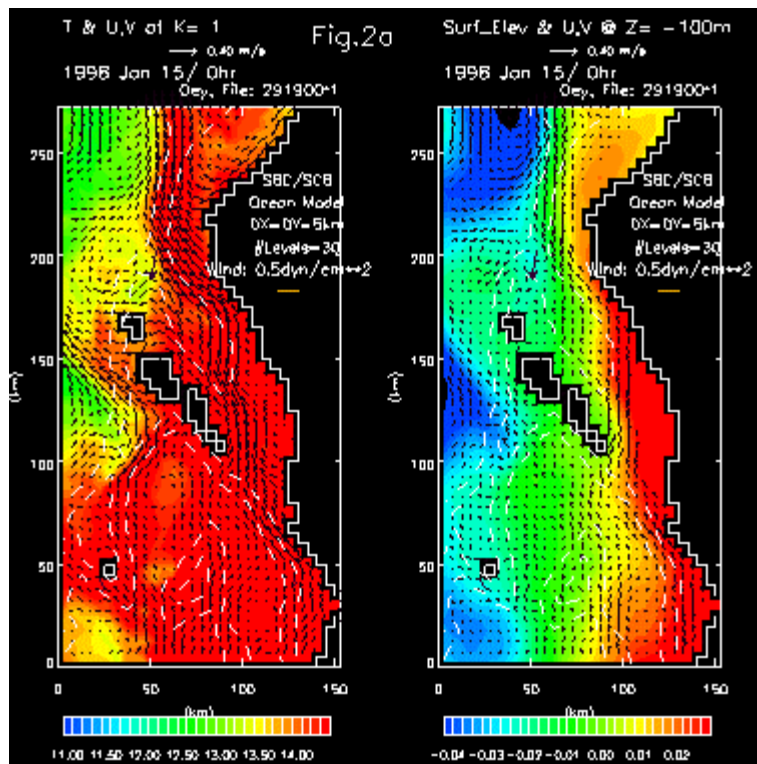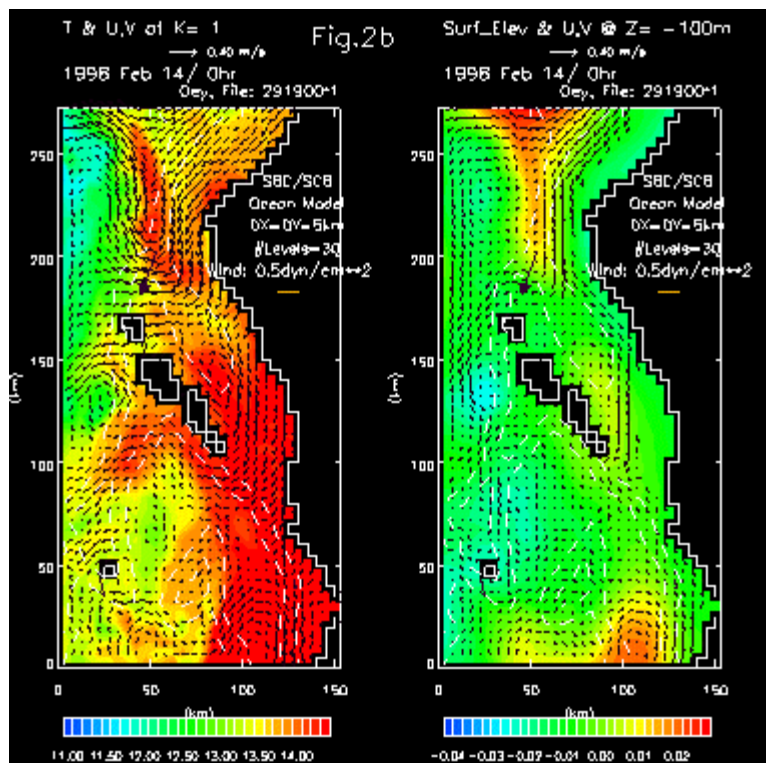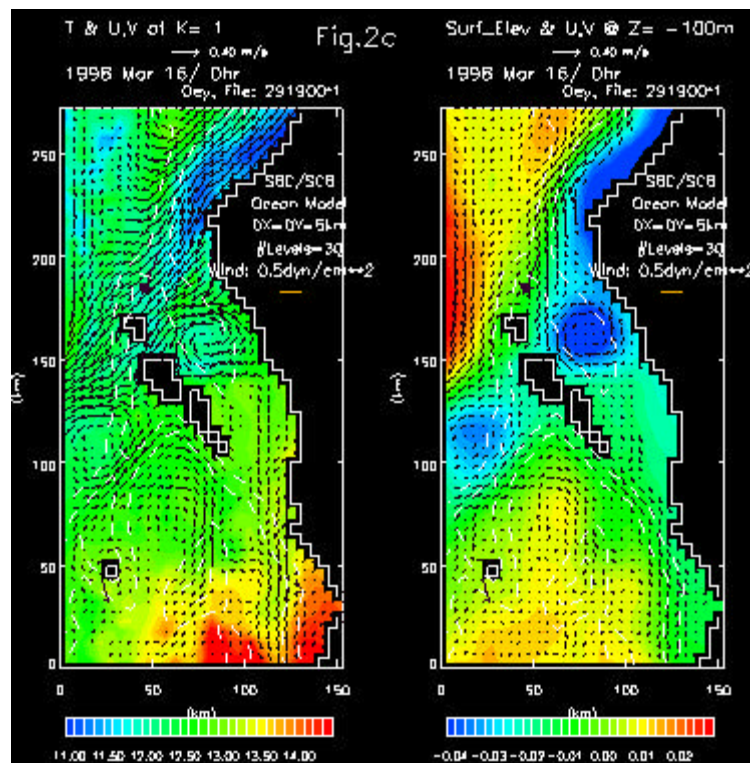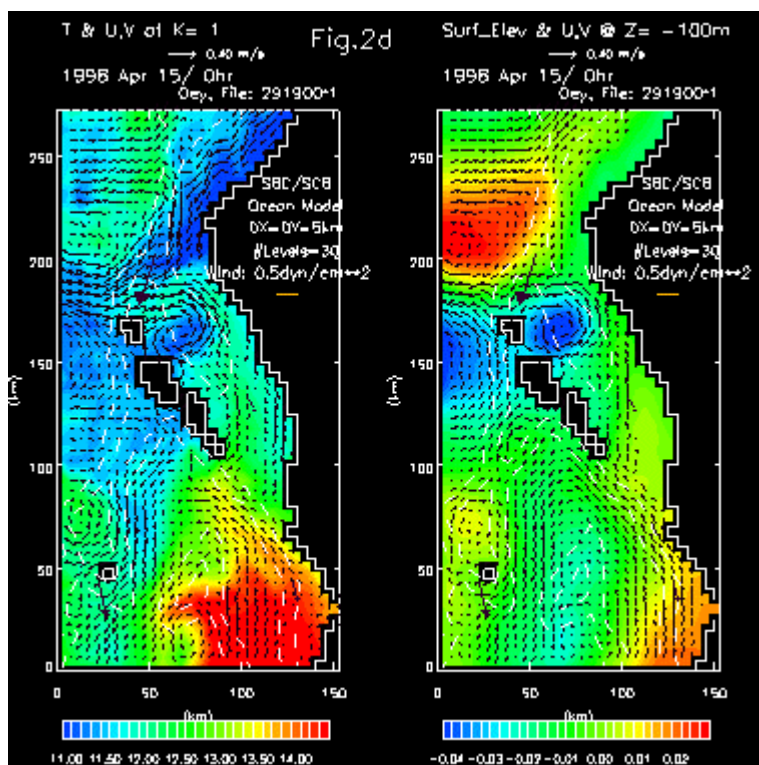

Figure 2a

Figure 2b

Figure 2c

Figure 2d